Chair of Communication Networks
Department of Electrical and Computer Engineering
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NetBOA: Self-Driving Network Benchmarking

Andreas Blenk*

Joint work with:

Johannes Zerwas*, Patrick Kalmbach*, Laurenz Henkel*,
Gábor Rétvári^, Wolfgang Kellerer*, Stefan Schmid°

**Technical University of Munich, Germany*
^Budapest University of Technology and Economics, Hungary
°Faculty of Computer Science, University of Vienna, Austria

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Today’s Approach of Operating Networks?

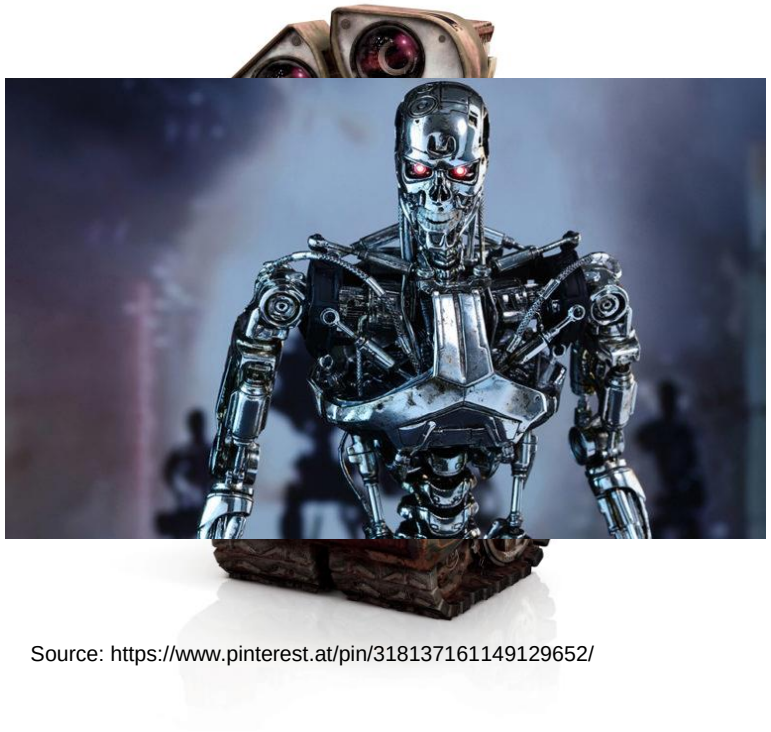
Monitors → Network Problem

Optimizes → Solution

Designs → Performance Evaluation

With more complex networks need for automation!

What Self-Driving Networks Should Do



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Self-Monitoring → Network Problem

Self-Optimizing → O'zapf t is (BIG DAMA'17) / Solution / Empowerement (SelfDN'18)

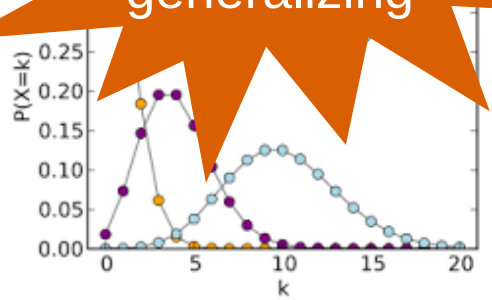
Self-Benchmarking → Performance Evaluation / NetBOA (NetAI'19)

Benchmarking Network Algorithms, Architectures etc…

The Traditional Way …

Not always available

Traces



Not generalizing

Models

Hmm… Biased?

Human‘s Best Guesses

Alternative opponent?

Data-Driven

This Talk: Use Machine Learning to Benchmark Networks (or more concrete network functions) …

What Could be Seen as Related

- Algorithmic complexity attacks (software domain):
  - SlowFuzz
  - PerfFuzz
- *Automated Synthesis of Adversarial Workloads for Network Functions*, ACM Sigcomm 2018
- **Policy Injection: A Cloud Dataplane DoS Attack**, ACM Sigcomm DEMO 2018

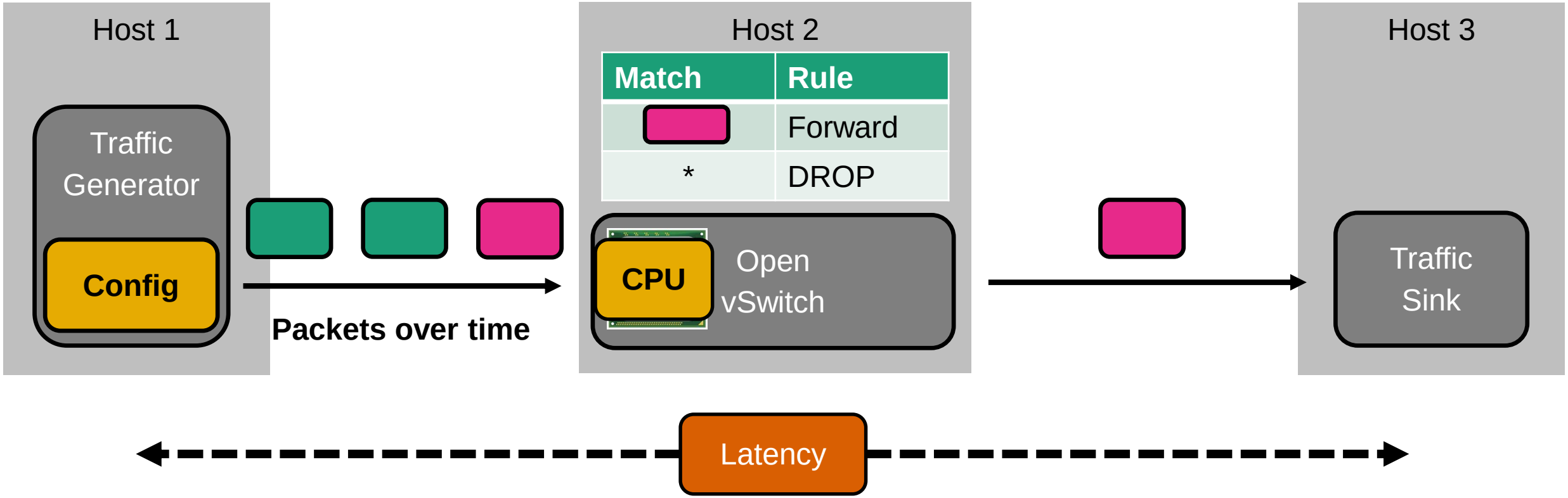
Why Important?

Implementation aspects can harm performance

Could even be used to attack your systems!

We propose NetBOA to automatically create network traffic input

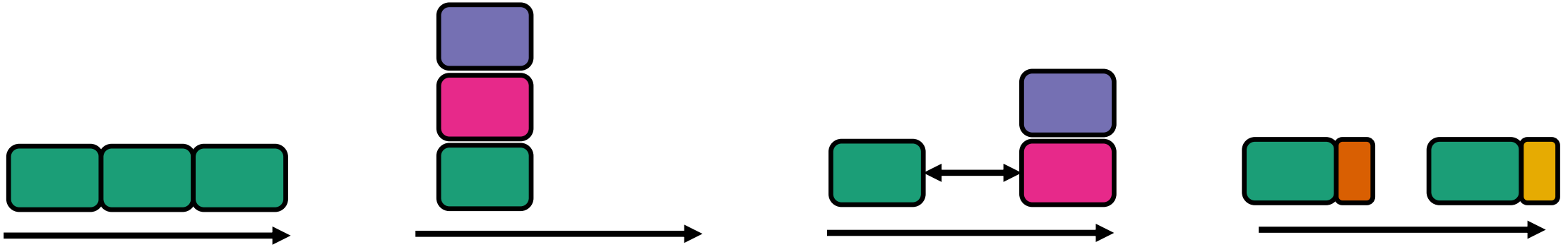
Use Case: Benchmark Open vSwitch



Goal: Find Network Traffic Configuration that Maximizes CPU/Latency

Network Benchmarking is Challenging: Complex and Huge Configuration Space

How many packets to send? How should headers look like? What protocol to use? When to send packets? Etc.



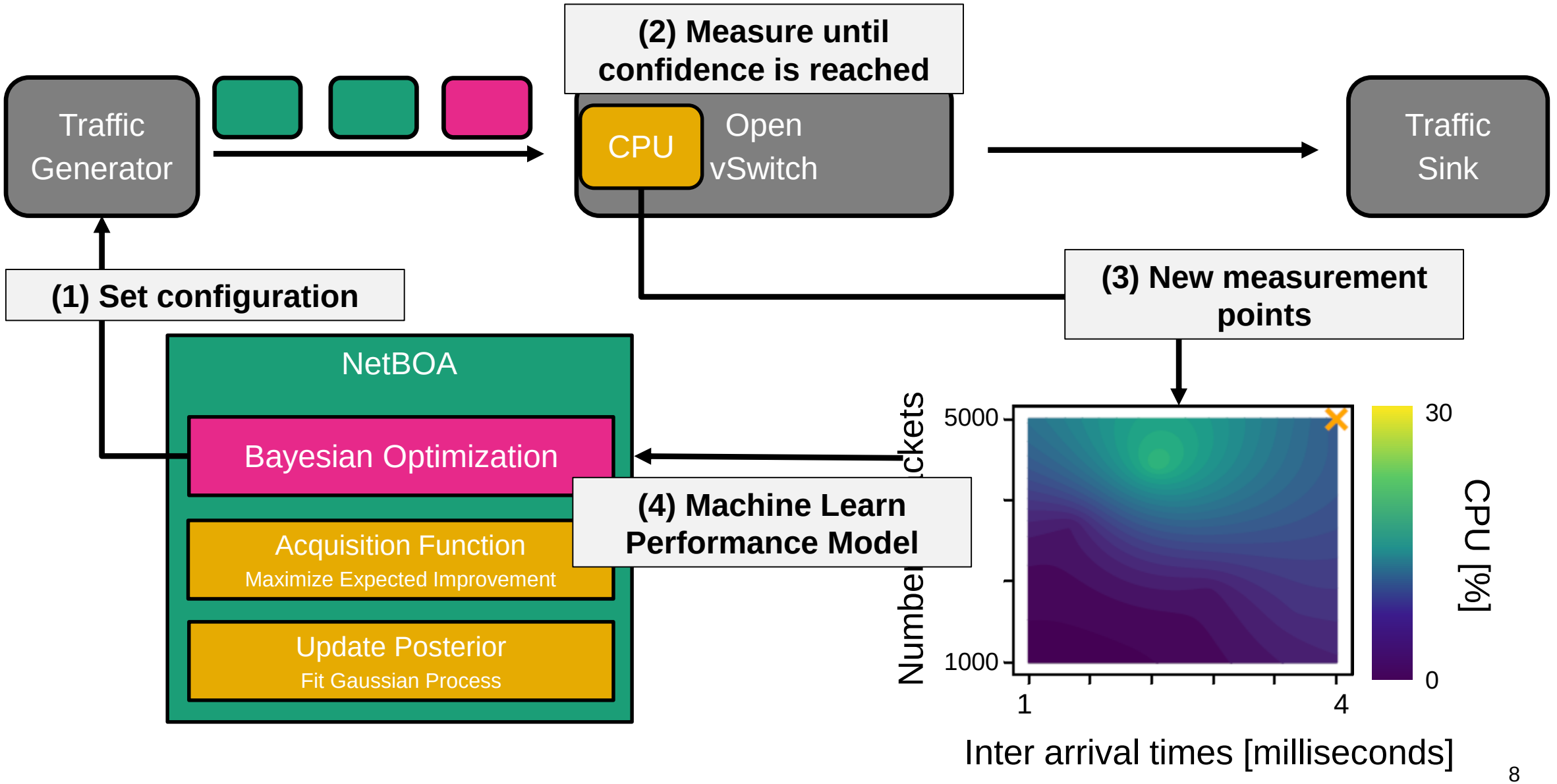
Number of Network Packets [1000 – 5000]

Batch Size [1-5]

Packet Inter Arrival Time [1ms – 13ms]

VLANs [1-5]

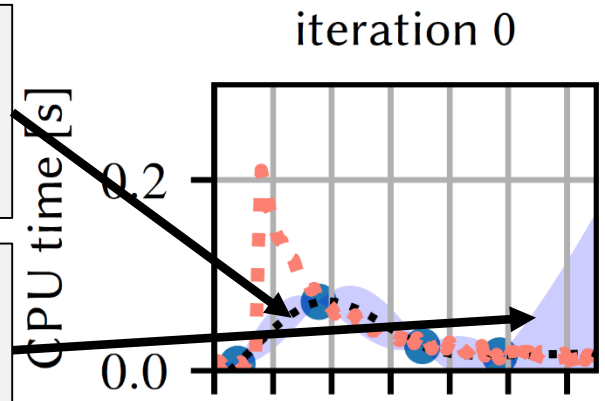
NetBOA: The Bayesian Optimization Measurement Loop



Bayesian Optimization: NetBOA for Inter Arrival Time (IAT) Parameter

Update Gaussian Process at runtime

Sampling from Gaussian Process gives confidence



ping criteria
orts search

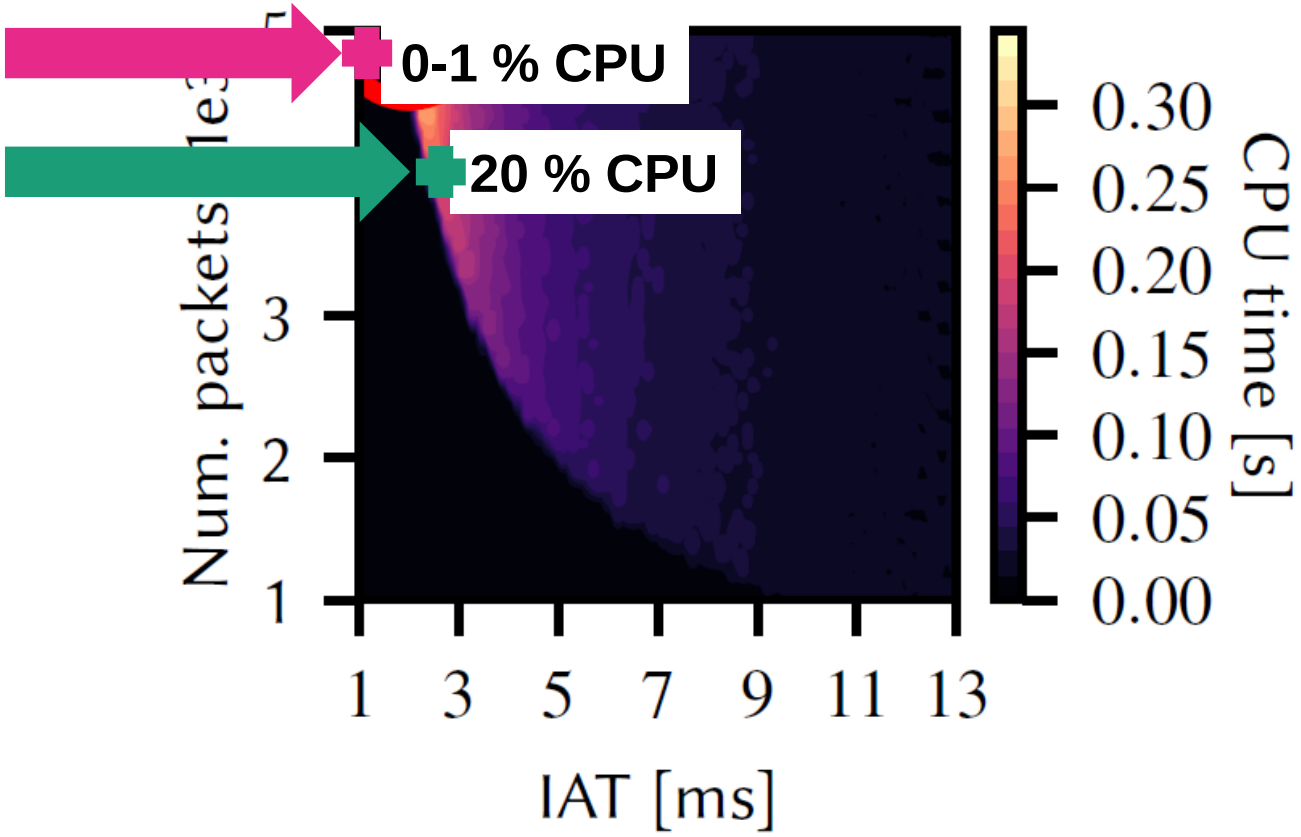
guides search

Evaluation: Compare NetBOA with GridSearch and RandomSearch

Grid Search for Two Parameters (Num. Packets and Inter Arrival Time)

5000 packets, IAT 1 ms

4000 packets, IAT 3 ms



- Performance models are non-trivial
- **Surprising:** Sending less network packets over time can lead to significantly higher CPU

Why? Let Us Look At OvS Behavior!

Match	
1	Drop

Match	
1	Drop
2	Drop

Match	
1	Drop
2	Drop
3	Drop
…	…
N	Drop

Match	
2	Drop
3	Drop
…	…
N	Drop

Match	
1	Drop
2	Drop
3	Drop
…	…
N	Drop

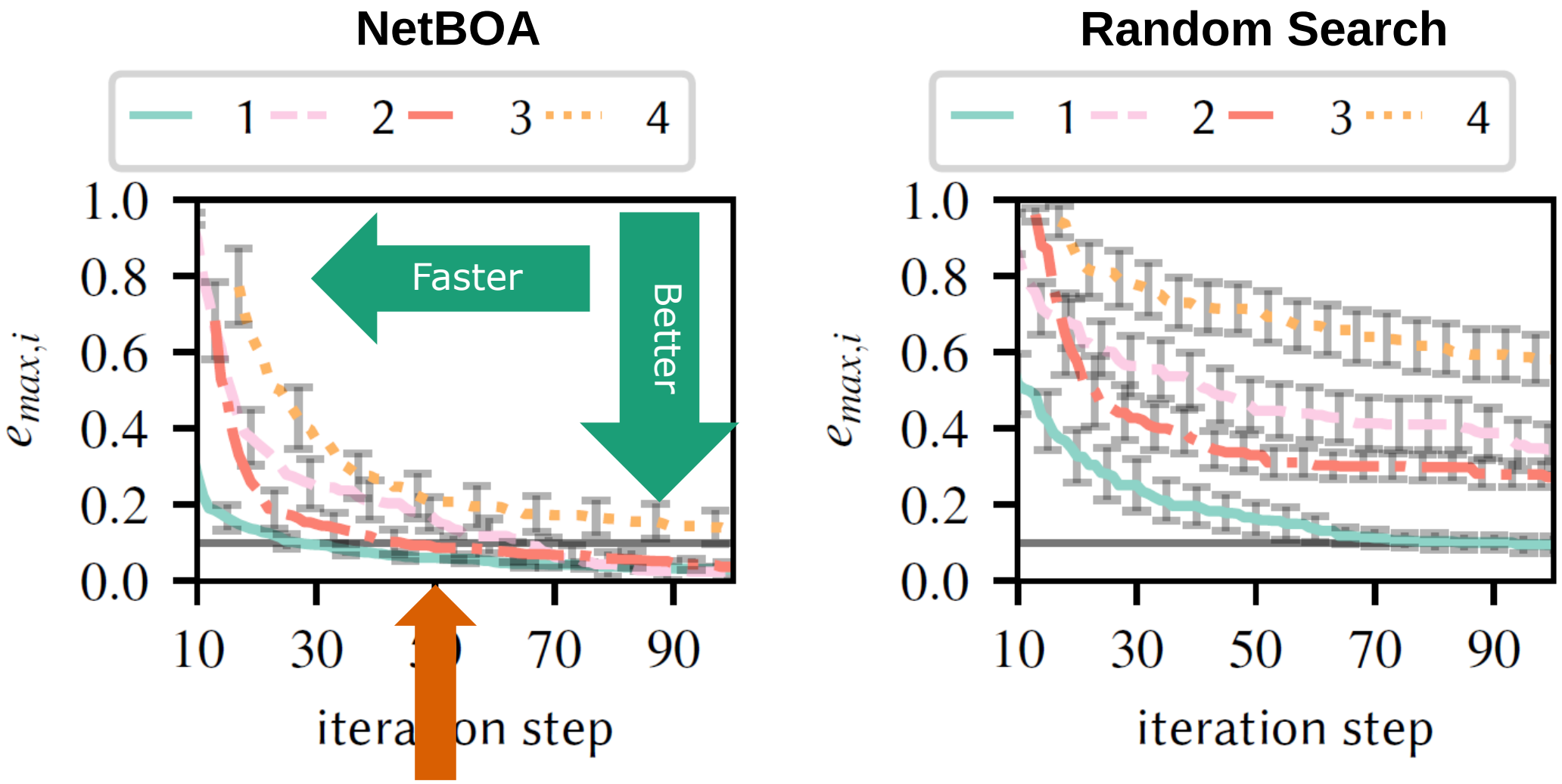
Every packet triggers 2 times a costly array resizing operation!

OvS rule timeout 10 seconds

- We are using the OvS switch with the **Megaflow Cache enabled**
- For instance for 5000 packets: We trigger roughly every >2 ms a flow insertion + removal

→ **Forcing OvS to continuously run through the array + resizing it**

NetBOA vs Random Search



24 % higher CPU utilization

Conclusion

- Summary: NetBOA is a Bayesian Optimization-based data-driven approach to generate network traffic configurations for benchmarking network function implementations

→NetBOA can efficiently find challenging network traffic configurations (maximize CPU/Latency)

→NetBOA can also be used to minimize, e.g., CPU or Latency

- Open questions and problems:
  - Does beating the machine means it generalizes?
  - Does it scale?
  - Alternatives?
  - Bayesian Optimization needs also tuning!

References

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[NetAI’19] Zerwas, Johannes; Kalmbach, Patrick; Henkel, Laurenz; Retvari, Gabor; Kellerer, Wolfgang; Blenk, Andreas; Schmid, Stefan: NetBOA: Self-Driving Network Benchmarking. ACM SIGCOMM 2019 Workshop on Network Meets AI & ML (NetAI '19), 2019

Thank you!

Questions?